INTERNATIONAL DATA SPACES ASSOCIATION

JOINTLY PAVING THE WAY FOR A DATA DRIVEN DIGITISATION OF EUROPEAN INDUSTRY

INTERWEAVING IDS AS A REFERENCE ARCHITECTURE FOR THE DATA ECONOMY WITH RELEVANT INITIATIVES

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- Position Paper of members of the IDS Association
- Position Paper of bodies of the IDS Association
- Position Paper of the IDS Association
- White Paper of the IDS Association

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The specification of the International Data Spaces Association forms the basis for open, federated data ecosystems and marketplaces ensuring data sovereignty of the creator of the data.

1 Setting the scene – Opportunities and Challenges of a Data Economy

Digital industrial platforms integrate different digital technologies and real-world applications, processes, products, and services. European industry needs to come to agreements on functions and interfaces for those platforms, reference architectures and interaction protocols that have the potential to create markets and market opportunities leading to ecosystems and standards.

This is not only true for the manufacturing industry when talking about Industrie 4.0 but also for several other verticals like agriculture, healthcare, energy or public administrations and cities.

Europe has an excellent opportunity to define standards and to create platforms with global reach in this B2B area as it combines excellent process and IT know how. The Digitising European Industry Initiative of the European Commission is a key element of the Digital Single Market strategy and heavily supporting and guiding this approach. The interim report of this program published in March 2018 underlines three 'Promising digital industrial platforms building on European strengths:'

- RAMI 4.0 (Reference Architecture Model Industrie 4.0)
- Industrial Data Space (now named International Data Spaces)
- FIWARE

The Platform Industrie 4.0 as well as the International Data Spaces Association where both founded in Germany whereas the creation of FIWARE started at the beginning of this decade within the 'Future Internet Public Private Partnership' of the European Commission together with several European companies.

The Platform Industrie 4.0 is focussing on the digital vertical integration of the manufacturing industry whereas the International Data Spaces Association is focussing on the management of data across different verticals. As the FIWARE Foundation is focussing on Context Information also across different verticals both are sharing the same vision although there are different focus areas which are enhancing each other.

Today, there is a common understanding that data is of high value. Leveraging this value and trading data creates huge revenues for the large data platform providers. Rarely, the creators of data are benefitting from this value in an adequate way. Often, only the cost for data creation and management remain with them. Furthermore, many give their data away for free or pay with it for the use of a service. Finally, others keep it for themselves without taking advantage of the value.

As today data is available through systems and platforms in different levels of quality and quantity, there is a need for vendor independent data ecosystems and marketplaces, open to all at low cost and with low entry barriers.

2 Sharing Data while keeping Data Ownership – IDS Approach

This need is addressed by the International Data Spaces (IDS) Association, a non-profit organization with today about 100 members from various industrial and scientific domains. The IDS Association specified an architecture, interfaces and sample code for an open, secure data ecosystem of trusted partners.

The specification of the IDS Association forms the basis for data ecosystems and marketplaces based on European values, i.e. data privacy and security, equal opportunities through a federated design, and ensuring data sovereignty for the creator of the data and trust among participants. It forms the strategic link between the creation of data in the internet of things on the one hand side and the use of this data in machine learning (ML) and artificial intelligence (AI) algorithms on the other hand side.

Digital responsibility is evolving from a hygiene factor to key differentiator and source of competitive advantage. Future data platforms and markets will be built on design principles that go beyond our traditional understanding of cybersecurity and privacy. Based on strong data ethics principles the IDS Reference Architecture Model puts the user in its centre to ensure trustworthiness in ecosystems and sovereignty over data in the digital age as its key value proposition.

IDS defines a reference architecture, which supports sovereign exchange and sharing of data between partner independent from their size and financial power. Thus, it meets the needs of both large and small and medium enterprises (SMEs). Further down the road, it may be taken up by individuals as well. Whether data of IoT devices is concerned, in on-premise systems or cloud platforms, the IDSA aims at providing the standard for sharing data between different endpoints while ensuring data sovereignty.

The IDS Association aims at reducing the entry barriers and, thus, the cost of data sharing and exchange. Finding and authenticating appropriate transfer partners will be substantially facilitated, so will the legal and commercial governance of transactions. This goal is achieved by creating a semantic standard for data sovereignty, i.e. the rules and policies that determine who is allowed to do what in which context with the data shared by the data owner. This is a key prerequisite for connecting the various existing and emerging proprietary platforms. The IDS allows ecosystem partners to define software readable contracts attached to the data. The contracts are based on usage control rules like duration of use, forwarding of the data etc. Furthermore, the purpose and cost of data use can be specified. IDS certified software allows for modelling, configuring, monitoring and enforcement of the rules and polices specified in data contracts.

A first minimal viable product (MVP1) will be available in the fourth quarter 2018. A number of software companies are working on their implementation of the IDS definition. To ensure interoperability certification will be offered early 2019 (MVP2).

With this, the definitions of the International Data Space Association have potential to form a global data exchange standard.

3 Fiware Foundation

FIWARE is a curated framework of open source platform components which can be assembled together with other third-party platform components to accelerate the development of Smart Solutions in different sectors.

FIWARE has proven to be useful in the development of vertical smart solutions, addressing a specific challenge (e.g., smart parking or smart waste management in a Smart City, a solution for the smart management of silos of grain in farms, a smart solution for the predictive maintenance of machines used in factories, etc) or more complex smart solutions designed as "system of systems" dealing with the overall management of processes within a given organization (e.g., a Smart City, a Smart Farm or a Smart Factory). As an Open Source initiative based on common European research and development, FIWARE has achieved a relevant adoption as a data platform.

4 Synergies and alignment between FIWARE and IDSA

While FIWARE as a mature initiative has a broad acceptance and a high technical readiness level for the availability of data and the basic needs of data exchange the IDSA Initiative focuses on new aspects of the usage of data regarding trust in an ecosystem, interoperability and the governance of data usage. The maturity and acceptance of FIWARE is a foundation for new concepts and technologies that build the data economy. The adoption of NGSI-LD as a common standard for European data marketplaces based on various technologies and platforms in combination with Usage Policies and trust-enabling mechanism like the IDS Dynamic Trust Management build a strong foundation for the industrial data exchange with the perspective for the consumer market as well. Nevertheless the main focus for Europe is the secure and sovereign exchange of data between companies and organizations detached of technologies, platforms and vendors. An aligned development of IDSA and FIWARE will strengthen this approach.

5 Architecture alignment with IIRA, RAMI, IVI, IoT-A

Finding the appropriate system architecture is one of the design decisions with the most impact on the long-term success of any IT environment. Regarding the relevance and complexity of the topic, several initiatives around the world collected their views in several reference architectures in order to support decision makers, developers, or system architects. While the input from different communities lead to slightly differing scopes and prioritizations, the shared understanding on the internet technologies and their implications as the central backbone of any data exchange serves as a common ground for future developments.

In the following, we briefly present the output of the major current IIoT initiatives, namely of the International Internet Consortium (IIC), Platform Industry 4.0, FIWARE Foundation, the European Lighthouse Project Internet of Things Architecture (IoT-A), and the Industrial Valuechain Initiative (IVI), their overlaps with the IDS but also their unique features and possible extensions.

5.1 IIRA

The reference architecture [1] published by the IIC aligns to a significant extend with the IDS Layer model. While the specific scope of the IDS on data sovereignty leads to a stronger focus on configuration, modelling and integration, the IIC Reference Architecture (IIRA) mainly discusses the IIoT challenges from an integration and interoperability perspective. The IIRA regards concerns of a broad audience of stakeholders, consequently explaining a heterogeneous set of requirements and implications. In summary, the central IDS aspects can be aligned with IIRA's Functional Viewpoint and its subdomains, with additional correspondences to the viewpoints Usage and Implementation (Fig. 1).

Even though IIC and IDS rely on a similar terminology, the according interpretations above the network layer differ significantly. Whereas IIRA specifies general economic tasks and workflows (ERP, SCM) in their Business Domain, including stakeholders and their objectives, the IDS Business Layer defines the various participants of the data space according to their contribution. The differing understanding of the term 'business' underlines the necessity to reach a common understanding for both idea exchange but also technical integration.

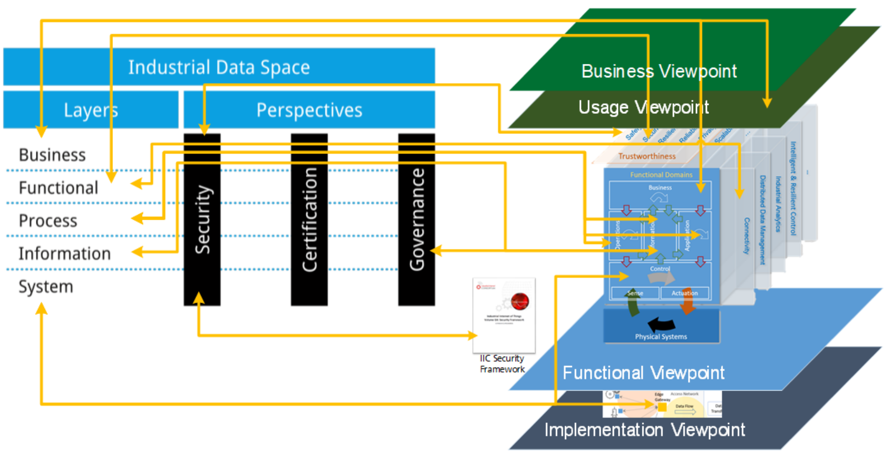

Figure 1: Correspondent categorizations of IDS and IIRA

In order to enable the necessary semantic interoperability, the IDS Information Model outlines detailed explanations and formal definitions in a declarative manner. IIC concepts are textually described, lacking according machine-interpretable definitions. The IDS therefore provides valuable resources for IIRA compliant applications, whereas the IIC scope on communication and connectivity aspects extends the lower layers of the IDS.

IDS Connector as a Gateway for the IIRA

The IIRA specifies the need of a gateway for industrial data exchange. With signing a memorandum of understanding between the IIRA and IDSA both will elaborate on the use of the IDSA Connector Architecture as a Gateway in the IIRA.

5.2 RAMI4.0

The Reference Architecture Model Industry 4.0 (RAMI4.0) [2] outlines a comprehensive view of manufacturing related implications to any IoT landscape. The primary topic, the integration of the physical asset and its digital representation, is proposed relying on a common representation called the Administration Shell. In contrast to the IDS focus on a trusted data exchange, RAMI4.0 concentrates on the integration of shop and office floor components in great detail.

The different requirements lead to slightly different interpretations and modelling approaches. The physical object, and thereby the Administration Shell, are the first class citizen in RAMI4.0, in contrast to the IDS focus on data assets. While the connectivity of physical assets, their integration and interactions are discussed in detail, IDS further specifies secure data exchange patterns across networks and organization borders.

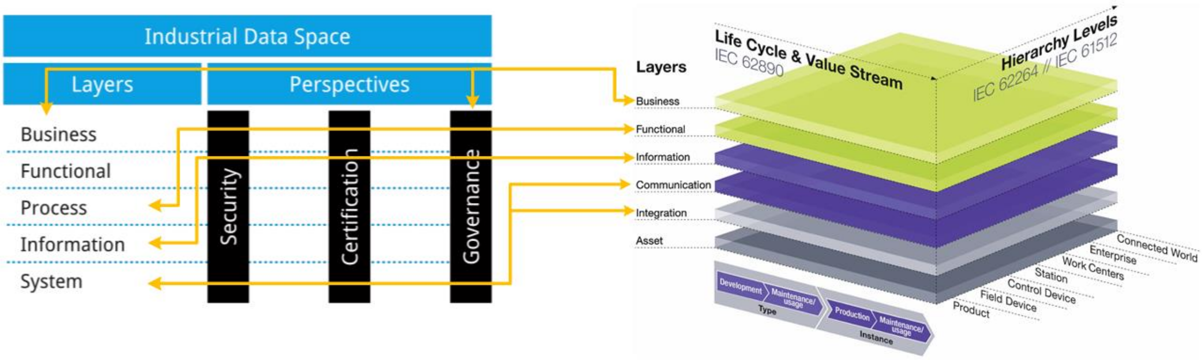

Figure 2: Above the Asset Layer, RAMI4.0 and IDS share a common layer structure.

Certain differences also exist regarding on the interpretation of the Information Layers. Whereas the descriptions of the IDS layer have a solely informative and describing character, RAMI4.0 also includes data processing, analytics and transformation aspects. IDS delivers a core vocabulary of formally defined terms, RAMI lacks an according counterpart. Physical properties of assets on the other hand are missing in the IDS Information Model, therefore being a suitable extension point for IDS descriptions as certain well-known vocabularies (eCl@ss) are proposed by both models.

Network and integration related topics as defined by the Communication and Integration Layers overlap with the IDS System Layer. The major differences between both models is the emphasis on the cross cutting perspectives (IDS) and lifecycle and organizational hierarchy (RAMI4.0). In order to enable a cross-organizational data exchange, security, certification and governance are the key consideration at all levels of IDS. RAMI's focus on the integration of physical objects and manufacturing plants takes these aspects for granted, creating a significant potential for respective connections and extensions.

IDS Trusted Connector and the Administration Shell

The Administration Shell serves a standardized IIoT interface, providing both metadata and identification mechanisms. The IDS Trusted Connector has similar functionalities, extended with specifications to serve as a secure and trustworthy gateway for any kind of data assets. Its main conceptional difference is its nature as a gateway to access and control data without necessarily being the origin source, which is required for the Administration. Nevertheless, an IDS Connector can comply with the Administration Shell specifications and vice-versa.

5.3 IoT-A

The EU flagship project 'Internet of Things - Architecture' (IoT-A) [3] delivered an unified vision and guidance for transforming existing isolated solutions into an integrated IoT. The outlined Architecture Reference Model presents an extensive list of requirements on nearly any aspect of IoT architectures, allowing a structured categorisation of technologies, protocols and best practices according to the defined layers and perspectives. With its main focus on achieving interoperability in means of communication and information exchange, the IoT-A Architecture Reference Model serves as major step towards internet-based technical integration of heterogeneous systems.

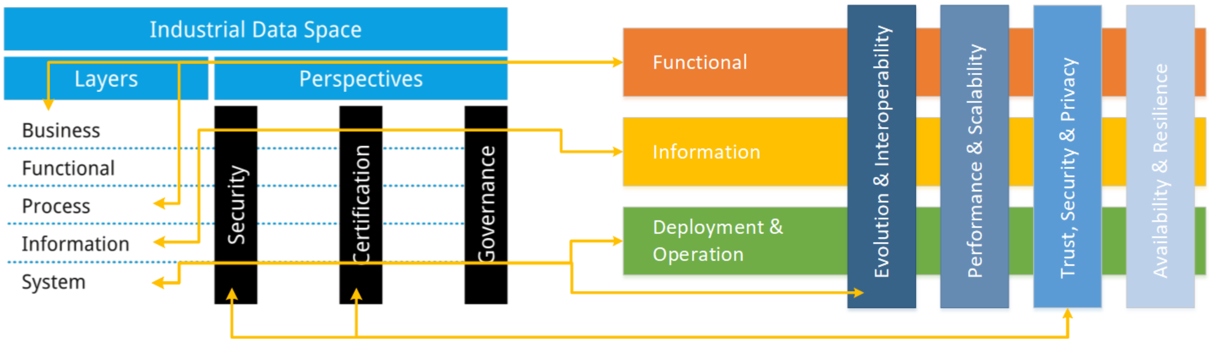

Figure 3: The IDS scope on data sovereignty and secure communication targets nearly all layers of the IoT-A Architecture Reference Model (own illustration).

Although mainly discussing IoT topics and connectivity of physical objects and devices, the insights outlined by IoT-A are highly relevant both for the IDS and any other data-driven integration platform. Especially the asset and component related suggestions on the lower layers serve as a framework that the IDS further specifies and implements in order to reach a seamless data exchange. The comprehensive explanations on functional and communication topics by the IoT-A project are extended by the IDS with indeep considerations on data security, privacy and governance. In addition, the IDS defines a more detailed data model and interaction patterns especially for security and authentication procedures. Therefore, the IDS can be regarded as an IoT-A compliant architecture with extended specifications but also concrete implementations for a secure and trustworthy data exchange.

IDS connectivity for IOT-A

As IoT-A defines the data exchange in IoT, the IDS Reference Architecture can be applied to the further use of data in the industrial context. Data generated from the IoT is necessary to enable cloud based IoT solutions as well as Big Data solutions and finally Artificial Intelligence. The IDSA Reference Architecture Model enables the free flow of data between the IoT, Cloud-based systems, Big Data and IoT while focusing on necessary and cross-cutting concerns like data sovereignty and data provenance.

5.4 IVI

The Japanese Industrial Value Chain Initiative (IVI) proposes an additional architecture outlining industrial data sharing between Smart Manufacturing Units (SMU). Each SMU acts as an independent organizational entity, capable to connect and exchange data with other SMUs. While the definition of an SMU matches the IDS definition of an organization hosting an IDS connector, the regarded attributes are less technical specifications but rather generalized organizational considerations. The respective IVI guidelines are less detailed than the ones provided by IDS, resulting in descriptions of business processes between SMUs rather than defining technical handshakes and interaction patterns as targeted by the IDS Reference Architecture Model. Nevertheless, the strong focus of IVI on the manufacturing organization as its first class citizen complements the IDS views especially regarding the different business roles and commercial interactions. At the same time, the in-depth analysis of data privacy and security elements by the IDS enables the business-related considerations proposed by IVI.

IDSA and IVI

The alignment of the IDS Initiative and IVI started and is backed by various ministries in Germany, Europe and Japan. In addition the signed memorandum of understanding between IDSA, FIWARE and IVI describes a way to a common understanding of best practices, architectures and data usage.

6 Options for actions in the EU

The various presented approaches range from being essentially surveys of reference points and best practices to efforts to set de facto standards for data sharing architectures. While being inspired by a similar understanding on the relevance of the topic and the upcoming challenges, the respective prioritizations of regarded topics differ significantly. Whereas IIC and IoT-A outline general features of physical objects and their virtual counterparts, RAMI4.0 specifically targets the manufacturing industry, and IDS focuses on trustworthy data exchange. The essence of all these approaches has the potential to create a comprehensive picture of technologies, design patterns and communication models.

Nevertheless, coordination between the approaches happens mainly on a bilateral level, lacking coordinated efforts and transparent differentiations. The resulting threshold for interested parties is further increased by the variety of created architectural descriptions without a shared framework. One has to notice that every approach targeting a new, unifying model will most likely result in only increasing the already existing stack of meta-architectures. In addition, a central top down coordination has very limited prospects of success. Instead, a structured, transparent and up-to-date overview on existing initiatives is necessary. Providing comprehensive criteria on respective targets and regarded concerns, combined with references to the current efforts will enable concerned parties to efficiently retrieve required information and reduce both the existing uncertainty and lack of knowledge.

A necessary starting point requires sufficient search capabilities and supported views depending on the background of the user, equal to a map that enables the exploration of a certain landscape. The underlying dataset needs continuous maintenance regarding the momentum of the topic and the frequency of published updates, as well as meaningful structure to enable the representation of the relationship between the different approaches.

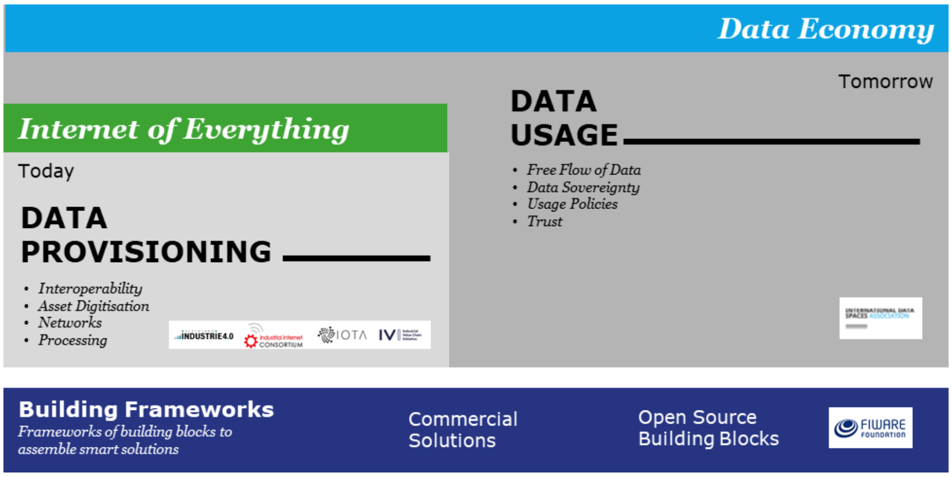

Figure 4: From data provisioning to data usage (own illustration).

The recent European activities focus on the generation of data and the fundamental exchange of data to satisfy the needs of the European industry. As data is available today the focus has to change to the free flow of data and the use of data. Closing the gap between existing architectures, platforms and solutions, respect for the value of data as an economic asset and building a governance for data usage are key challenges for the future. Here FIWARE as well as commercial solutions will pave the path from today's efforts to provide data in and for defined ecosystems to the usage of data in comprehensive ecosystem with respect for the underlying conditions. The major effort for the data economy of is the interoperability of data platforms, data catalogues and data marketplaces, based on a meaningful description of data, trusted identities as participants and partner and a common awareness of the individual value of data and the need for the protection of this value. The IDS builds the concepts for the Data Economy as a joint effort and idea among its members and is backed by the implementation of the concepts by its members as a commercial solution or an open source solution in various shapes, depending on the need of the application.

Creating a reliable foundation for data marketplaces

Being able to manage data like any other company asset, in order to create the basis to offer smart services, is becoming more and more important for companies that want to excel in the market. Data marketplaces are enablers for this trade of data assets and at the end for the creation of the digital single market. It needs a trustworthy foundation, a commonly accepted – thus standard-like – reference architecture, to finally enable the data economy to evolve. It is precisely the collaborative, innovative combination of data from various sources like clouds, open, company-specific or jointly gathered data sources (so-called club goods) that makes these promising new services and business models possible.

Making AI happen

The availability of data from the Internet of Things and the Internet of Services as well as Big Data capabilities of various kinds enable Artificial Intelligence. AI is already and increasingly will be a game changer in every industry heavily depending on data of various kinds. Here a build-in mechanism is needed, that guarantees the respect for data provenance and usage policies. At the same time the need for interoperability, free flow of data and trusted identities is high.

Going for global standards for B2B platforms

In the context of Digitising European Industry the EU invests around €300 million in next generation platform building and piloting, during the 2018-20 period. This Strategic Positioning Paper describes the existence of several well developed approaches for digital platforms. Some of the investment should be used to further align the European based initiatives to join forces for the following alignment with other major global platforms like the above compared IVI from Japan and IIRA from the US. Following this approach, the EU will have a real chance to set global standards and to win a major stake in the battle on B2B platforms.

References

[1] Industrial Internet Reference Architecture V1.8, 2018

[2] DIN SPEC 91345: Reference Architecture Model Industrie 4.0. 2016.

[3] Bassi, A., Bauer, M., Fiedler, M., & Kranenburg, R. V. (2013). *Enabling things to talk*. Springer-Verlag GmbH.

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